



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

NOTES ON THE GREEN BUG (*TOXOPTERA GRAMINUM* ROND.) IN TEXAS.*

E. S. TUCKER.

THE following notes relate to the writer's first experimental work in Texas, which consisted of an investigational study of the green bug (*Toxoptera graminum* Rond.). Under appointment as entomological field assistant, the project was entered upon on May 6, 1907, and prosecuted until the end of the year, at Plano, Collin county.

As a result of the sweeping outbreak of the green bug earlier in the year, the grain growers of northern Texas in particular, which country comprised the principal grain-producing section of the state, had suffered almost complete loss of their prospective wheat and oats crops. When the seriousness of the devastations first became apparent the grain dealers met and appealed for assistance towards determining measures for future control of the pest. In response the Texas Agricultural Experiment Station authorized an investigation, the means being provided by an Adams fund apportionment. The arrangements included the fitting up of a field station at Plano, for which the grain dealers rendered financial aid that deserves grateful acknowledgment. The locality is typical of the black prairie region on northern Texas, and up to this disaster grain growing had been carried on here extensively.

At the time of the writer's arrival on the scene only a very slight percentage of the early grain acreage had been spared with any prospect of making a fair yield, the ravaged fields generally having been plowed and planted to corn or cotton. On account of a change of natural conditions, as explained later, the season proved very unfavorable for a proper study of the green bug, especially regarding its summer habits. The present notes, however, deal only with matters aside from the serial breeding of the insect. All records which contained the main results of work have since been unfortunately destroyed by fire.

* Published by permission of Prof. B. Youngblood, director of the Texas agricultural experiment station, which instituted the work.

THE SPOTTED LADYBIRD-BEETLE AS AN ENEMY OF
THE GREEN BUG, AND A STATEMENT OF
FIELD CONDITIONS.

Comprising a part of the investigation experiments were begun in July for the purpose of determining the efficiency of the spotted ladybird beetle (*Megilla maculata* De G.) as an enemy of the green bug. This ladybird which together with its associated relatives was more ordinarily but less becomingly called ladybug by the farmers, appeared to be the most common and consequently the best known of its family occurring in northern Texas. In the country about Plano the adults of this species alone, without considering the larvæ, were the most conspicuous and abundant of all beneficial insects observed in the wheat and oats fields during May and June.

The other inimical insects were chiefly *Scymnus loewii* Muls., *Hippodamia convergens* Guer., and *Chrysopa plorabunda* Fitch. Previously the aphid parasite, now known as *Aphidius testa-ceipes* Cress. (Formerly *Lysiphlebus tritici* Ashm.), being reported by Prof. C. E. Sanborn, who had watched the fields from the start of the outbreak, had played an important part in reducing the green bug to the point of extermination, and then had vanished suddenly itself. Its absence, therefore, precluded it from further consideration. Besides, owing to the scarcity of the green bug, which at last completely disappeared soon after the middle of June from under observation in the fields, the stock for experimental purposes was necessarily bred on oats and wheat seedlings in pots and cages. However, other grain aphides, principally *Siphocoryne avenæ* Fabr., survived sporadically in the fields in spite of the different ladybirds and associated predators, and subsided upon the plants until their nourishment failed, whereupon a marked development and dispersion of winged migrants took place.

In the expectation that a similar development would occur with the green bug, so it might be enabled to reach other host plants for the summer, preparations were made for subjecting a number to the same field conditions by stocking tight muslin-covered field cages with introduced colonies. But as the grain plants had already begun to dry and turn yellow at the time, the bugs failed to thrive long enough for any noticeable change to take effect. If the experiment had been started earlier, while the field plants were succulent, so as to have allowed the

bugs an opportunity to breed abundantly and establish themselves thoroughly, the trial would have afforded better chances of success. The delay in making preparations was caused by the failure to receive the cages in proper time.

But in considering the spotted ladybird, the changing conditions brought on by the maturity of the grain crops seemed to cause this insect scarcely any concern until the general drying of the plants had practically resulted in an obliteration of the usual dependent pests. The individuals then began to hunt in a leisurely movement for a fresh food supply, and naturally concentrated in the last failing green spots and edges of the fields, where they apparently obtained a precarious subsistence temporarily. They were by no means clear of the fields when the crops were harvested in the last week of June and first week of July, but at last the barren stubble enforced their complete dispersion. After lingering for a few days in the weedy edges, the last straggling beetles finally disappeared, and scarcely any trace of the species could be detected anywhere during the remainder of the summer. The reason for such scarcity of this insect seemed to be clearly due to the lack of suitable prey, especially since none of the former pests of the grain fields, on which the beetles doubtlessly depended for feed, appeared in any other situation covered by exhaustive search.

Although the spotted ladybird is not considered a distinctive aphid feeder by all authorities, it nevertheless thrived well in confinement upon a diet of green bugs, but at the same time manifested cannibalistic tendencies to devour its own eggs. Its life and behavior under these conditions were carefully observed and the particulars noted.

Female beetles in confinement deposited eggs in clusters containing altogether at a laying, so far as observed, from seven to thirty eight eggs. These eggs were characteristically cemented endwise upon the surface of the glass jar used for cages. A single cluster, whether comprising the whole or only part of a laying, seldom contained as many as fifteen eggs. Whenever a larger number was laid at a time the eggs were usually deposited in separate small clusters.

Whether the disposal of eggs in such manner is designed by the mother ladybird as a precautionary measure for the benefit of her young, thereby indicating a maternal concern, is an interesting question, since the corresponding separation of

small groups of larvæ consequent to the hatching of the eggs would reasonably be expected to afford an important advantage to the young under natural surroundings by preventing an extreme preponderance of them on one plant or part of a plant, where if all issued in a mass they would be confronted with a proportionate competitive risk of finding live prey not only ready at hand but also in sufficient quantity. Inevitable as the risk must be in any case, yet the larvæ, which at first are almost helpless creatures, have an opportunity to prepare for the critical occasion of obtaining prey, though only in a feeble way at the best, but which is still highly essential for their welfare.

In support of this conclusion, the conduct of those in confinement has furnished evidence to denote that live prey is not immediately demanded, because the newly hatched larvæ first partook of their egg shells and made no effort to seek further food for at least a day afterward. Obviously their future career depends at this juncture upon finding a fresh food supply within convenient reach, and not to exceed, at the most, any short distance to which the tender young larvæ may be able to wander.

Even in instances concerning those under observation, the larvæ failed to sustain themselves, although they were inclosed in a small jar with an abundance of live green bugs on fresh blades of grain which lay on the bottom within a few inches, or at the most not farther than four inches, of the larval birthplace; and besides, the green bugs frequently crawled close around the spot where the larvæ rested. As to the death of these larvæ, no definite cause could be ascribed otherwise than to starvation as a result of natural weakness that incapacitated them from obtaining live food, although as a possible factor in imposing a devitalized state, consideration was given to artificial breeding conditions. But in view of the fact that other larvæ succeeded vigorously, the effect of confinement could not have been of material consequence; and furthermore, the usual outcome would discredit any question of objection to the kind of prey. Of all reasons considered, the intensely hot weather at the time of these failures might have exerted the real detrimental influence.

The probable importance of distribution, first in small groups and later by scattering of individuals, is a point to be

deeply considered as affording several chances in different places whereby some if not all of the larvæ composing an issue may succeed in overtaking the prey. This feature might serve to prime advantage, particularly during a time of food scarcity, by saving an issue from utter failure, which would more likely be the case if the entire number of larvæ issued forth all together in one place rather than in small groups at separate places. For if one spot should be destitute of prey, another might happen to be propitious. Without the support of positive evidence concerning the larval relations in nature, any discussions on this line must necessarily be very incomplete, but the following remarks are introduced as a summary of conclusions.

At the time a young larva ventures upon the active course of its life it is still a frail creature. Its strength is hardly yet sufficient to enable it to wander far in search of food or to withstand much hardship. On account of its own weakness and the hazardous conditions to be faced in nature, its chances of passing not only the most critical period of its life when it starts out into activity, but of its entire course, cannot always be promising. Furthermore, it is liable to suffer from competition with its fellows at the start, but only in a limited degree, since the primary demands are slight. With gain and growth in strength, gradual separation of individuals occurs, and without doubt lessens the danger of competition, which may eventually be reduced to insignificance or be entirely eliminated by extensive scattering of the older larvæ.

The time of development from a freshly laid egg to the maturity of an adult ranged from 16 to 20 days, in periods as follows: for hatching of egg, 2 to 3 days; for growth of larva, 10 to 12 days; and for pupation, 4 to 5 days. The particulars of the nearest complete records of development are shown by the following two cases:

Eggs laid.	When hatched.	First molt.	Second molt.	Third molt.	Fourth molt.	Pupa- tion.	Matur- ity.	Total time.
Aug. 13	Aug. 15	Aug. 18	Aug. 19	Aug. 21	Not seen	Aug. 25	Aug. 29	16 days.
Aug. 23	Aug. 26	Aug. 28	Aug. 30	Aug. 31	Sept. 2	Sept. 7	Sept. 12	20 days.

The number of green bugs consumed by the ladybird larvæ during their period of growth was determined by actual count,

taking old and young *Toxoptera graminum* just as they occurred on oats and wheat seedlings and supplying them to these young *Megilla maculata*, each being separately confined. The counts were made promptly at the beginning and end of each daily supply, and the missing number of green bugs in each case was reckoned as the actual consumption by the ladybird larva for the day. The entire results are herewith recorded:

DAYS.	1	2	3	4	5	6	7	8	9	10	11	12	Total.
Larva No. 1.....				19	26	28	26	63	32	70	58	end	322
Larva No. 2.....			8 1 7	31	10	19	28	49	65	80	30	end	330
Larva No. 3.....		7	7	18	10	37	39	41	93	99	103	43	497
Total combined.....													1,149

As the first meal of the larvæ consisted of their own egg shells, they did not commence to feed upon a supply of green bugs until one or two days after hatching, and in some cases longer. By simply transferring the larval ladybirds from one jar to another containing each supply of green bugs, no confusion could occur about the separate allotments.

In the same manner as was pursued with the larvæ, the feeding capacity of a pair of adults in confinement together—male and female, which matured from the reared larvæ—was determined for a period of 40 days, or from August 29 to October 7, in which time, 3,804 green bugs were devoured by them, thus accomplishing an average daily destruction of 95 green bugs. These figures show that a single adult ladybird is capable of eating approximately 50 green bugs every day. These two beetles were still alive at the end of December, when the work ceased, but they had become dormant on the approach of cold weather, and therefore very clearly indicated an aptitude for passing the winter in a true state of hibernation.

At no time throughout the experimental test did these ladybirds lack an abundant supply of live green bugs. Every apportionment of such food was provided somewhat in excess of the amount which the beetles really consumed within the duration of the allowances, in order that the insects might be tempted to feed to their utmost capacity. In the treatment of the larvæ the food supply was furnished every day for the purpose of keeping an exact daily record; but with the adults a reckoning of the amount of their consumption was not always

made with the same regularity, and sometimes included two days without the need of a fresh change to maintain a degree of enticement.

Despite these ample provisions, the female ladybird repeatedly ate her own eggs, and the male in a few instances was also observed in the same act. If the insects were free in nature such cannibalistic tendencies might be obviated in a great measure on account of the insects being at liberty to rove, but otherwise the quantity of prey consumed would very probably in most cases be considerably less than what the experimental deductions show. Only during extreme infestation of fields could prey be found as available and constant in volume as would compare on an equal basis with the supply furnished for the experimental tests, with the difference, of course, of no expenditure of energy being required on the part of the ladybirds for hunting in small imprisoned spaces. In restricted confinement the beetles could not fail to find the supply of food provided for them, whereas in freedom they would be apt to meet with uncertain or irregular provision, owing to the variable occurrence of prey. Even in time of abundant spoil the roving disposition of the ladybird may possibly lead many individuals far astray from the areas of infestation. The prospect of decimation appeared most perilous during midsummer, which may be regarded as the prevailing period of seasonal adversity, for in this interval the natural restriction of prey subsequent to the maturity of the small grain crops certainly reacted with disastrous effect on the spotted ladybird.

One serious fault to be found with the spotted ladybird, if not also applicable to many of its relatives, as was learned from observations regarding its attention to aphid prey in the fields as well as in confinement, is the evident fact that it is a vacillating hunter. Its movements are decidedly erratic and therefore too variable from any proper course to be fully effective in overtaking prey to the best advantage or wherever the latter might occur most numerously. Hunting in a random sort of way, the beetle seems to miss the greater share of prey in any general path which the individual pursues, and one may even brush past a particularly infested plant without showing the least concern.

Still effective work by it may be possible in case that a sufficient number of beetles abounds so one might chance upon what prey another has failed to find. Its faculties for de-

tecting the prey seem quite inadequate, because the beetle has been seen time after time to run directly over or even dislodge many green bugs or other aphides from their positions on the blades of plants and not exhibit any sign of perception of these objects. Only when a ladybird happens to run its head against an aphid, so that the mouth parts or palpi come into contact with the body of the prey, does the beetle appear able to recognize the presence of a victim. Since the beetle wanders from leaf to leaf in a hasty manner, making but brief pauses at various distances, it actually runs over numbers of aphids and needlessly sweeps them off of its path by the gripping motions of its legs. The aphids which fall to the ground upon being dislodged from a plant by the movements of a ladybird when it traverses a blade have a chance to crawl back on the same or another plant and reestablish themselves.

Another faulty trait to be charged against the spotted ladybird, and in particular to the larva, is accountable to the insect's fondness in feasting on wingless green bugs in preference to the winged forms. Unless a ladybird should likely be very hungry, the winged green bugs are liable to be spared for choicer morsels as presented by the apterous forms. Possibly the migrants can oftentimes make their escape on the approach of a predaceous foe, especially if it should be a clumsy ladybird.

On the whole, the importance of all the useful ladybirds is obvious, and a recognition of the various kinds in their different stages will enable the agriculturist to avoid mistaking and heedlessly destroying them as supposed pests, when instead they should be treated with friendly regard and afforded every possible protection and encouragement for the valuable service they render.

BREEDING FACILITIES IN WORK WITH GREEN BUGS.

For isolated breeding of *Toxoptera graminum*, a sufficient number of pots in which food plants have to be grown is an essential requirement. A special type of galvanized iron pot with a capacity of about a peck measure, and having a tube connected on the outside for conducting water as needed into the earth contents from beneath the surface, was used with much satisfaction. Common earthen flower pots answer admirably, and even ordinary tin cans were utilized on emergencies.

Glass chimneys or globes were used for enclosing the plant after a green bug had been isolated upon it, and as a further measure of protection against accidents or enemies, the top of the chimney was covered with a piece of muslin cloth held tightly in place by a rubber band. Although care was taken to set each chimney firmly in the earth, yet rats and mice occasionally succeeded in digging under the base and thus gained access to and destroyed the seedling, usually causing the loss of the isolated bug. Owing to the danger of these rodents, despite the warfare that was made upon them, but little safety would have been afforded by the use of muslin bags supported on wire loops. Of all protective methods considered, glass globes have the advantage of offering practically no obstruction to light and view. Any kind of enclosure, however, will interfere with circulation of air and tend to increase temperature and humidity, and so far as muslin is used will furthermore reduce sunlight. All of the imposed influences produced by such causes must be taken into account as being at a variance with natural conditions.

Grain seedlings were grown in beds under field cages and transplanted in pots a day or two in advance of actual needs. By careful nursing during the hot weather a vigorous growth could be secured and depended upon for sustenance of the bugs in isolation. Oats sprouted in midsummer much better than wheat, and always survived more successfully after being set in pots.

The process of isolating the young bugs involved the greatest risk in dealing with them. They were transferred with best success by means of a dampened point of a fine camel's hair brush. Examples often had difficulty in attaching to the plant on which they were placed. Attempts to induce them to hang on a blade sometimes proved very vexatious. After some losses had occurred with individuals which failed in this manner, the placing of paper sheets on the earth surrounding the stem of the plant was found to be a wise plan. Then in case a young bug fell from a leaf it could readily be recovered and possibly replaced by patient attempts.

For shelter a special tent of strong canvas was erected on a framework of 2 by 4 in. lumber. The posts were set securely into the ground, being cross-braced to withstand heavy winds or severe storms. In accordance with the changes of weather,

the slack or shrinkage of canvas was easily kept at the proper tension by the adjustment of guy ropes on stakes in the usual way. Further strength and safety was secured by nailing a 12-inch ground board to the posts on all the sides and ends except across the space allowed for entrance, and the lower edges of the tent walls were tacked to this board. This construction also permitted an additional height of a foot for inside working room. In size the tent was 12 by 14 feet.

The ventilation of this tent was accomplished by the removal or only partial opening of the gables as desired, this feature being quite important. The gables, in fact, were independent sections that were held in place, when wanted, by means of buggy knobs fixed to the face of the rafters and cross-frame, and with eyes to match on the edges of the section of canvas itself. As the tent stood lengthwise in a north-and-south direction, with the entrance facing the north, the usual south winds had free range through the open gables and afforded a comfortable temperature inside during the hottest weather. The overhead air currents seldom interfered with the work of transferring young bugs, because the walls constituted an effective shield against the generally constant breeze. Strong and equally diffused sunlight was a distinct advantage that no other form of shelter having a darkened roof could possibly permit. Considering all the circumstances, this tent answered the purpose of an insectary quite satisfactorily, being especially suitable for temporary field work.

SYSTEM FOR ISOLATED BREEDING OF THE GREEN BUG.

Two breeding series, one being called the generation series and the other an individual series, were propagated for the purpose of acquiring detailed information upon the phases of development of *Toxoptera graminum*. In both series a system of designating the isolations of individuals was necessary to prevent confusion. My system as is outlined herewith, if not fully serviceable in so far as was employed for breeding the green bug, may perhaps be adapted for similar work with other aphids.

The main object in breeding generations was to carry on a lineal series with firstborn from first-matured individuals in order to determine the rate of successive occurrences in different months and in the whole length of time covered. Other particulars, such as developmental, maternal and total

life periods, daily and total reproduction, proportion of wingless and winged forms, and of sexes, were also noted to a certain extent without interfering with the regular succession of progeny.

In attempting to conduct breeding tests to the fullest extent and at the same time avoid too much complication in the process, the establishment of an individual series became necessary. As a matter of course, the stock for this series had to be drawn from the generation series, but it was not allowed to disarrange or risk in any way the direct line of descent nor to lose its relative connection, else the entire work would have been made worthless with regard to individual relations.

Generation Series. An explanation of the method of conducting the generation series is presented in the following outline:

For generation 1 establish series with a fertile female.

For generation 2 isolate each of the young from mother of series in consecutive order of daily birth, and number accordingly, 1, 2, 3, 4, 5, etc. Promptly designate each individual as "Gen. 2, No. —," for positive identification. Select No. 1 as mother for generation 3; in case No. 1 fails of reproduction, substitute No. 2; or if this fails, take No. 3; and so on by successive individuals if required further. Keep the life records according to actual dates, but in reckoning the continuity of generations on the basis of development from first-born individuals, deduct any loss of time, if more than a day, which the substitute should have in place of No. 1. With proper practice failures seldom occurred with more than two or three consecutive individuals of a generation, and very rarely amounted to as much as the loss of a day in difference of time.

For generation 4 and following ones, proceed in the same manner, designating each individual upon isolation by the proper "Gen. — and No. —."

Individual Series. The method pursued in conducting the individual series requires the following explanation:

This series should be begun with No. 2 of generation 2, provided it does not fail and is not needed as a substitute in the generation series; but No. 3, 4 and 5 of the same generation should be held in reserve against possible failures or accidents. All depends upon No. 1 having succeeded in pro-

pagating the generation series before No. 2, if alive and doing well, can be safely released from sharing responsibility in the continuation of the generation series. Otherwise, if the need of substitutes in place of No. 1 should require any of the successive individuals, or if No. 2 alone should fail, the starting of the individual series must be postponed until generation 3, or, if necessary, until a further one has advanced far enough to allow the serial separation of the desired individuals.

Continue this special breeding of serial offspring by selections from the generation series until each differently numbered individual has been treated for whatever purpose intended. In explanation, this statement does not mean, when in case No. 2 of generation 2 is used that No. 3 need be of the same generation, but rather of the following generation, and so on for all the numbers. However, should the matter of saving time be an object, provided that facilities for isolation are ample, two or three numbered individuals of a generation may be treated at one time with little risk of the results being at any material variance with results in case of similarly numbered individuals from different generations.

Whenever an individual has been carried as far as desired, or when the young are not wanted for this particular breeding, remove the superfluous bugs to a general stock cage or destroy. The stock cage is needed to furnish a supply of bugs for experiments with predators, and, when possible, with parasites; also for tests with different host plants, and for use in other ways including general observations.

PROBABLE INFLUENCE OF HOT WEATHER UPON THE GREEN BUG.

The experimental breeding of *Toxoptera graminum* during the summer months was somewhat disappointing in the outcome by not producing any change of form from the serial wingless viviparous females. In the stock cages, however, winged females appeared to constitute a moderate and fairly uniform proportion at all times in comparison with the predominant number of wingless females. The probable influence of hot weather culminated in no discernible effect except upon the fecundity of the bugs in the serial breeding.

Three or more factors, whose separate or combined influences might possibly have been exerted on the breeding of the

insects under observation, unavoidably entered into the experimental work, so that the reason for any change in the course of the lines of the insects could not be definitely attributed to the effect of one element alone, even such as temperature, without being proved by corroboration. One important factor which was apt to produce abnormal effects arose from the employment of artificial measures for breeding purposes. The responsibility of such circumstances demanded watchful consideration, and any unusual manifestation of the bugs needed to be conclusively understood and verified with regard to all features involved.

Therefore, as many questions remain open to dispute, no positive significance of results can be declared without substantiation by further experiments for one or more years. Hence progress in determining the reasons for effective results must necessarily be slow in order to be reliable.

The artificial condition under which the bugs were bred corresponded as nearly as possible with natural conditions, but still differed materially because confinement of the bugs was imperative. More constant and substantial provisions were required for studying these insects under close observation than could be offered them in nature. In consequence the bugs were afforded the best of advantages for their sustenance and propagation.

The most noticeable feature which was evinced during the summer in the existence of the bugs was a falling off in the number of young bugs born every day. From the standard daily production of eight young bugs by one adult the birth rate declined to three or four young ones per day, seldom being more, but often less, and rarely none at all. This reduction of one-half or more in the usual multiplication of the bugs could not be proved to have been caused by hot weather when other weighty reasons demand consideration, especially with regard to the effects of artificial conditions and continuous breeding from one generation to another without the intervention of males. However, this curtailment of the reproductive capacity was partly redeemed by a tendency of the bugs to attain an early maturity and begin bearing young ahead of the regular time. Such irregularity was shown in a number of instances, requiring only five or six days instead of the ordinary period covering eight days. Maturing in advance of the usual time hastened the appearance of consecutive generations.

Attempts to breed the bugs in the open sunshine eventually proved unsuccessful. These tests, however, demonstrated the hardiness of the bugs in withstanding a few days of exposure to sun heat, and then the failures were evidently induced by the wilting or scorching of the food-plants rather than to the direct effect of heat on the bugs. In one case, as long as the plant remained in a fresh condition an adult bore young, and all seemed to thrive for a few days in spite of being enclosed in a glass globe, which subjected both the plant and its tenants to a temperature several degrees higher than would have been the condition if the colonized plant were openly exposed to air. This test was made on a bare space of ground wholly unprotected from the sun during the hottest and driest days in the last week of August, and it met disaster from the baking heat of the first day of September.

Another test giving proof that green bugs can stand more than 100° F. was demonstrated in the field or stock cages. These cages were constructed of wood frames, three feet square by 4 feet in height, covered with muslin cloth on all sides and top, and banked with earth around the bottom edges. Oats or wheat seedlings grown in these cages were colonized with green bugs, which multiplied rapidly at all times. Frequent watering of the soil in these cages was necessary to keep the plants in succulent growth, so that in addition to the temperature the interior was charged with a high humidity. Although the cloth covering subdued the glare of the sun, nevertheless the temperature inside probably ranged from 10° to 15° F. higher than on the outside.

The experimental results prove that *Toxoptera graminum*, when provided with suitable food plants and also protected from the baking heat of the sun, is able to live through the summer. This fact in itself indisputably refutes the popular impression that the species in any active form cannot withstand hot weather under any circumstances. The adverseness of natural conditions during midsummer principally accounts for the seasonal suppression of the insects, and these influences may rule for a number of years in keeping the pest under control.

Since no resting stage could be found when the bugs disappeared from the fields, the opinion gained common credence

that the pest had died out entirely. While this event might be possible in local instances, yet, in face of a logical consideration, the belief that extermination had become general was promptly discredited as being unreasonable as well as misleading. In the first place, if green bugs or any other kind of insect should wholly perish on account of one or more adverse seasonal conditions without having deposited eggs for reestablishing its kind after the critical period had passed, such species would become extinct.

At harvest time, when the grain plants ceased to furnish nutriment for sustaining the pest, all the bugs apparently disappeared. But this incident did not make certain the prevailing notion that all had died. That the pest still existed in the country was evidenced by later developments, although these were not determined until the second season following. The species must therefore have survived the summer in some obscure manner and in such scarcity as to have escaped observation.

Even before the grain plants matured, the pest became scarce owing to the activity of its enemies instead of the effects of warmer weather, further than that the latter condition favored the enemies. Wingless forms seemed to perish outright with the drying of the plants, but the winged forms, being amply fitted for migration, doubtlessly flew away in search of some succulent plant on which they and their progeny could subsist. Just what shift these bugs make, lasting from harvest time until the fall planting of small grain has sprouted, could not be determined, as has been explained. Several kinds of grasses, however, are known to serve as alternative or possible summer food plants. The bugs evidently exist in some way, since they reappear in the fall or in successive seasons on the young grain plants in the fields.

On the whole, the experimental breeding of green bugs proved fairly successful throughout the hot and dry weather of July and August. The unfortunate part of my work at the end was occasioned by the abrupt termination of operations at the time when development of true sexual forms had barely become effective. Hence, this discontinuance resulted in the incompleteness of observations concerning oviparous females,

of which the first example matured late in November; but further, the closest attention failed of detecting any male examples.

AGRICULTURAL EXPERIMENT STATION, BATON ROUGE, LA.

DETERMINATIONS AND RECORDS OF INSECTS COLLECTED AT PLANO, TEX.

By E. S. TUCKER.

DURING the time extending from the first week in May to the end of December, 1907, which the writer spent in an investigation at study of the green bug (*Toxoptera graminum* Rond.) at Plano, Collin county, Texas, a fairly representative collection of insects was personally made in the locality. Although circumstances have since caused much unavoidable delay in the work of determining the species taken, yet the results of study of a considerable number of the specimens have been published from year to year. Some examples still remain unidentified, but as the names of most species obtained in the collection are now known, the further determinations and records can be presented herewith.

This paper is the sixth one treating of the collection, and the papers all together give a nearly complete report.¹

In the present lists, the number of forms reported is 416, belonging in the different orders, as follows:

Diptera.....	184	Hemiptera.....	155
Siphonaptera.....	1	Thysanoptera	1
Hymenoptera.....	73	Corrodentia.....	1
		Chilopoda (Myriapoda).....	1

Adding the 398 forms, as have been previously reported, to the number now cited makes a grand total of 814 species and varieties.

As many as sixteen new species and one new subspecies have been named from examples studied by myself or sub-

1. (a) Incidental Captures of Neuropterous Insects at Plano, Texas. (*Psyche*, v. 15, Oct., 1908, pp. 97-100.) Number of forms cited, 34.
- (b) Incidental Captures of Lepidoptera at Plano, Tex. (*Psyche*, v. 16, June, 1909, pp. 58-64.) Number of forms cited, 130.
- (c) Incidental Captures of Apterous and Orthopterous Insects at Plano, Tex. (*Ent. News*, v. 20, July, 1909, pp. 294-297.) [For "Plana," in heading, read "Plano."] Number of forms cited, 40.
- (d) Incidental Captures of Cleoptera at Plano, Tex. *Can. Ent.*, v. 42, July, 1910, pp. 229-237.) Number of forms cited, 178.
- (e) Local Records of Arachnids Personally Collected in Kansas and Texas. (*Trans. Kan. Acad. Sci.*, v. 23/24, 1911, p. 240 and 241.) Number of forms cited for Plano, Tex., 16.